Not to be cited without
permission of the authors[1]

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 90/ 33

Ne pas citer sans
autorisation des auteurs[1]

Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 90/ 33

ASSESSMENT OF THE MARGAREE GASPEREAU FISHERY, 1989

by

Gérald J. Chaput and Claude H. LeBlanc
Science Branch, Gulf Region
Department of Fisheries & Oceans
P.O. Box 5030
Moncton, New Brunswick, E1C 9B6

[1]This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author.

[1]Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteurs dans le manuscrit envoyé au secrétariat.

ABSTRACT

The Margaree River gaspereau catch in 1989, estimated at 1,123 tons, was similar to the previous 5 year mean and was composed of greater than 99% alewife (Alosa pseudoharengus) by weight. The 1989 catch was dominated by the 1985 cohort (87% by number) and percent new recruits was similar to the average of the previous 6 years (61%). The contribution of 3 year old new recruits (1986 cohort) was 3%, the lowest ever. An abundance index based upon catch rates from logbook reports indicated that in 1989, alewife were less abundant than in the previous two years. Sequential population analysis, under Type I fishery assumptions, generated a 1989 fishing mortality of 0.80. Predicted alewife landing for 1990 at F=1.0 is 864 tons within a 90% confidence interval of 583 to 1463 t. In spite of increased sampling intensity, alewife or blueback herring older than 7 years of age were not sampled. The historical random samples weighted by lower river zone logbook catch were most similar to two-phase length stratified sampling from both zones of the river. However, differences in numbers at age of recruitment of 5 year old alewife and in proportion of new recruits were noted. Assuming sampling conditions in previous years suffered from similar bias to 1989, the catch matrix for 1983 to 1988 would be acceptable.

RÉSUMÉ

Les prises de gaspereau de la rivière Margaree en 1989, estimées à 1,123 tonnes, étaient semblable à la moyenne des cinq dernières années. Ces prises, composées de plus de 99% Alosa pseudoharengus dont 61% était de nouvelles recrues, étaient dominées par le cohorte de 1985 (87% en nombre). Les nouvelles recrues de 3 ans, cohorte de 1986, ont constitué la plus faible proportion pour ce groupe dans les prises jusqu'à date. Un indice d'abondance fut calculé en utilisant les journaux de prises et de l'effort et indiquait une abondance réduite en 1989 relative à 1987 et 1988. Une analyse séquentielle de population, effectuée selon les hypothèses d'un modèle de pêche de type I, a estimé le taux de mortalité dû à la pêche en 1989 à 0,80. La prévision pour 1990, à un taux de mortalité dû à la pêche de 1,0 s'élève à 864 tonnes dans un intervalle de confiance (90%) de 583 à 1463 t. Malgré un programme d'échantillonnage plus intensif en 1989, des gaspereaux âgés de plus de 7 années n'ont pas été retrouvés. Les échantillons aléatoires pondérés par les prises quotidiennes des pêcheurs du bas de la rivière ont générés un estimé des prises à l'âge semblable à des échantillons stratifiés par longueur. Cependant, des différences dans les proportions de nouvelles recrues ainsi que dans la quantité de poissons âgés de cinq ans ont été retrouvées. Si le biais d'échantillonnage des années précédentes était semblable ou moins que celui de 1989, la matrice de captures à l'âge de 1983 à 1988 serait acceptable.

105-03492/

INTRODUCTION

Annual assessments of the gaspereau fishery in the Margaree River have been presented since 1983 (Alexander 1984, Alexander and Vromans 1985, 1986, 1987, 1988, Chaput and LeBlanc 1989). Assessments of the 1987 and 1988 fisheries have estimated the fishing mortality on the spawning stock using Sequential Population Analysis (SPA or Cohort). A one day staggered closure per week, imposed in 1984, was maintained in 1989 with the river divided into two regulatory zones; a lower river zone, consisting of all waters downstream of NS Provincial Highway # 19 was closed to fishing on Friday 6:00 p.m. and all day Saturday and an upper river zone, consisting of waters above the Highway 19 bridge to the outlet of Lake Ainslie, was closed 6:00 p.m. Saturday and all day Sunday (Fig. 1). The fishery closed on June 30 as in previous years.

The absence of older gaspereau (aged 7+) in the fishery in recent years was highlighted as a concern by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) since it implied that fishing exploitation must have become excessive on that stock or the sampling was inappropriate. A sampling program in 1989 was undertaken to address the concerns expressed by CAFSAC. This document is structured into two parts. Part A addresses the following points:

1 - verification of the absence of older age groups by more intensive sampling of the fishery

2 - sampling at various locations along the river to determine if the historical sampling procedure represented the fishery.

Part B describes the 1989 fishery and presents the input parameters of the cohort analysis, under Type I assumptions, used to estimate the fishing mortality on the spawning stock. An abundance index, estimated from catch and effort logbook reports was used to calibrate the cohort analysis. Yield per recruit analysis, estimated under Type I assumptions, generated $F_{0.1}$ values. Prognosis for 1990 is provided using mean recruitment values for the last 7 years, estimated from cohort results.

METHODS

Historical sampling

Random samples of 25 fish per day were collected by the fisherman from the index trap sampled since 1984 (Fig. 1). Samples were frozen prior to analysis. Dates and samples collected are summarized in Table 1.

Two phase length stratified sampling

A two-phase length stratified sampling program was simultaneously undertaken in 1989. Length samples, consisting of approximately 250-300 measurements and a detailed sample of 5 fish per one-half centimetre length group, were obtained from various fishing locations in both management zones. Detailed samples were generally frozen for later processing. Daily sampling, in both zones, was stratified into AM & PM periods, and choice of period was randomly allocated, independently to each zone. Fishing locations sampled in each zone were randomly selected for each day within the constraints of the traps fishing on any particular day. Within trap variation was assessed by obtaining samples during both time periods from the same trap on the same day. Intertrap variation within a zone was assessed by obtaining samples from other traps within a zone on the same day. Locations sampled, dates and time periods are summarized in Table 1.

Detailed processing of samples

Biological characteristics collected include fork length (nearest quarter cm), whole weight (nearest gram), species (Alosa pseudoharengus; alewife or Alosa aestivalis; blueback herring), sex and scales which were removed from the left side of the fish, in the region midway between the dorsal fin and the ventral scutes. Species were distinguished on the basis of external appearance and peritoneum colour (Scott and Crossman 1973). Total age and age of first spawning were interpreted from scales according to criteria described by Cating (1953).

Fish lengths of frozen fish were adjusted to fresh lengths using the linear equation:

adjusted lgth (mm) = 4.557 + 1.0143 X frozen length (mm)

R-square = 0.96

Catch at age for the historical sampling and the two-phase sampling were obtained using the program AGELEN (Wright 1990) which calculates catches at age based on the equations of Gavaris and Gavaris (1983). Because species were not distinguished during the length sampling, a coded value of age representing species and age was used to determine catch by species and age with associated variances.

Logbook catch and effort analysis

Logbooks collected from individual fishing locations were processed for catch and effort (hours) by location. Reports of 0 effort or 0 catch were deleted from further analysis.

Total landings

Total catch for 1989 was calculated from the sum of the bait sales and from total pail counts of cured, packed gaspereau (a 50 lb pail of gaspereau was estimated to represent 32 kg of fresh fish).

PART A

As in the 1988 fishery assessment, catch at age matrices were calculated by age of recruitment for each species.

The catch at age from the random sampling program at the index trap was calculated, for comparative purposes, using three weighting schemes.

1) daily samples were weighted by the logbook report from the index trap only (as per Chaput and LeBlanc 1989). Unsampled days prior to the first collected sample were allocated to the first sampled day. Landings from unsampled days after the last sampling date were allocated backward to the last sample. Unsampled days during the fishing season were analyzed using a mean value of the before and after sample days.

2) Daily samples were weighted by the logbook catch from the lower river zone for that day. Unsampled day analyses were identical to that of Method 1 above.

3) Daily samples were weighted by the logbook catch from the entire river for that day. Unsampled day allocations are similar to Methods 1 and 2 except unsampled days during the fishing season which were allocated backwards to the previous sampling day as per Chaput and LeBlanc (1989).

Catch at age from the two-phase sampling program was estimated using 3 age-length key strategies. In all estimates, the method of projecting within catch interval by zone followed by summing across intervals was used (project and add Method).

1) Catch period keys by fishing zone which correspond to the relative abundance of gaspereau in the river as indicated in the logbook reports. Length samples were weighted by the daily logbook catch for the day, projected onto catch for the period and summed for all periods (5 in all) and two zones (Table 1).

2) Weekly age-length keys by fishing zone. Length samples were weighted by daily logbook catch, projected within week catch and summed across weeks.

3) Twice weekly age-length keys by fishing zone. Length samples were weighted similarly to Method 2.

Total catch at age was calculated using the ratio of logbook catch from the age-length calculations to total catch for the year. Catch at age proportions were compared using the procedure outlined by Smith and Maguire (1983) for

determining if samples originated from a common multinominal distribution.

Verification of the absence of older age groups (7+ years of age).

In spite of the increased sampling intensity, alewife or blueback older than 7 years of age were not found during the fishery period in 1989 (Table 2). Random samples collected from the index trap included alewife ranging in age from 2 to 7 years. Only 1 alewife out of 664 fish aged from the random samples (0.19%) was aged 7 years and it occurred on May 1 when the catch from the river was null. Stratified sampling generated alewife ranging in age from 2 to 7 years. A total of 3 out of 1922 alewife aged were designated as 7 year olds (0.16% of aged fish). Gaspereau were noted ascending the river during the first week in May, the first gaspereau to succumb to a partially installed trap was captured on April 29. If indeed, older age groups ascend the river first, then some older fish may have escaped to Lake Ainslie. Blueback aged 7 years were relatively more abundant than alewife, 0.92% of aged fish (Table 2).

Assessment of the historical sampling procedure.

In order to assess the representativeness of a sampling program, the true population structure must be determined. Under the assumptions of constant catchability, independent of trap location on the river, and equal fishing effort distribution, then the age composition of the catch in the lower zone should be similar to that in the upper zone, both representing the true age structure of the migrating population. An unbiased weighting method should result in similar catch-at-age proportions between zones.

Several aspects of the two-phase stratified sampling program as they relate to the estimation of the age distribution from the fishery are considered:

1) variation in age composition of the catch dependent upon time of day sampled,

2) variation among trap catches for the same day within a zone, and

3) overall variation among the two zones.

Replicate samples obtained from the same trap during AM & PM time periods were significantly different relative to age composition (Chi-square; $P < 0.001$) (Table 3). Time periods were randomly selected a priori for both zones independently to reduce any bias resulting from heterogeneous distribution of ages in the catch during the day.

Samples were obtained from several traps within a zone on the same day. Significant differences in proportion at age were also noted (Chi-square; $P < 0.001$) (Table 4). Sites were randomly selected daily within a zone within the constraints of the traps actually fishing that day thus among trap variation was accounted for.

The catch at age from the stratified sampling was estimated using three age-length key structures to account for differences in timing of catch and age composition (Chaput and LeBlanc 1989). The twice weekly age keys, by zone, were used to account for changes in age composition over time (Chaput and LeBlanc 1989). Weekly keys were based on management time periods by zone. Catch period keys were structured by zone on the basis of the logbook catch rates such that samples collected on the high catch rate days were aggregated together rather than being divided among two keys (Table 5, Fig. 2). In 1989, the peak of the daily catch occurred two days earlier in the lower zone relative to the upper zone (Fig. 2).

The catch period weighting strategy was most appropriate for constructing the catch at age in the 1989 fishery. There was no significant difference in the lower and upper zone proportions using the catch period weighting strategy, whereas significant differences were noted in the weekly and twice weekly key estimates (Table 5). When zones were combined, the proportions at age using the three weighting schemes were not significantly different (Chi-square, $P > 0.05$; Table 6). The coefficients of variation (CV) for the dominant age groups using the catch period weighting were equal to or less than the CV's from the weekly and twice weekly weighings for the age groups comprising over 90% of the catch (Table 6).

Random samples catch at age composition

In a previous assessment (Chaput and LeBlanc 198?) random samples were weighted daily by the logbook catch of the index trap only, because samples were only obtained from the index trap. During the 1989 fishery, catch from the index trap was not representative of the catch from either the lower zone or the entire river because of trap malfunctions during the peak of the run (Fig. 2). Consequently, alternate weighting schemes were used. The proportions at age and species using index trap weighting were significantly different from either lower zone weighting and entire river weighting (Table 6); the pairwise significant difference being noted for blueback herring age 5 years recruited as 4 year olds. Considering the lag in catches of gaspereu from lower to upper zones, the lower zone weighting method was considered the most appropriate for the 1989 historical sampling for comparison with the two-phase sampling results.

Having established an appropriate representation of the age and species composition of the 1989 fishery, the representativeness of the historical sampling program can be evaluated. Three aspects were evaluated:

1) differences in age composition,

2) changes in length of gaspereau during the spawning migration, and

3) changes in estimated species composition over time.

Catch at age composition

The proportions at age estimated using the catch period weighted stratified samples and the lower zone weighted random samples were significantly different (Chi-square = 34.0, df = 9, $P < 0.01$) as a result of differences in the proportions of 5 year old alewife recruited at ages 3 and 4 (Table 6). The species proportions were similar although the stratified sampling indicated a higher proportion of new recruits (first time spawners = FSP) in the 1989 catch than did the random samples (Table 6). Coefficients of variation were much lower in the stratified sampling compared to the random sampling, 6 of 18 CV's were less than 10% compared to 2 of 14 for the random samples. The lower CV's in the stratified sampling are in large part attributable to the larger number of samples aged.

The change in fork length of gaspereau over the spawning migration in upper zone, lower zone and random samples was examined with a dummy regression, homogeneity of slopes model accompanied by a lack of fit test (Neter et al. 1983). The fork length of gaspereau decreased over the season in the stratified samples from the upper and lower zones as well as random samples, however, the slopes and intercepts of the upper and lower zone regressions were not significantly different from each other but were significantly different from the random sample slope and intercept.

Zone	Parameter	P-value Parameter = 0	P-value Upper = Lower	P-value Upper = Lower = 0
	Slope			
Upper	-0.435	0.0001	0.409	0.0001
Lower	-0.417	0.0001		
Random	-0.258	0.0001		
	Intercept			
Upper	329.4	0.0001	0.274	0.0001
Lower	326.1			
Random	304.7			

The low overall R-square (0.11) for the homogeneity of slopes model reflects the large variance in length associated with each date. The lengths did not decrease monotonically over time which explains the significant lack of fit test for the above regressions. In spite of this, we can conclude that the distribution of lengths from the random sampling was quite different from that of the stratified samples (Fig. 3).

Species composition

There was no clear indication that the species composition of the stratified samples, by zone, was different from that of the random samples. Blueback were first identified from the random samples on May 23 and on May 29 from upper zone samples. Species composition was greater than 50% blueback after June 1 in all samples (Fig. 4).

Summary

Random samples collected from a single trap and weighted by the daily lower zone logbook catch were closest in age composition to that obtained from the stratified sampling but differed in the quantity and proportion by recruited age of 5 year old alewife, as well as in proportion of new recruits. The historical random sampling does not take into account variations in catch dependent upon time of day (do not know when samples are kept on any given day by the fisherman) as well as variations among traps. There were no gross differences in proportions at age between random sampling and stratified sampling in 1989, but the higher coefficients of variation from the random sampling make these estimates less reliable than the stratified sampling values. Assuming sampling conditions in previous years suffered from similar or less bias than in 1989, the catch matrix for 1983 to 1988 should be acceptable.

Variations in age composition between traps and within traps can be accounted for by sampling different traps during different time periods within a day. Stratification by zone is also an appropriate sampling strategy and when samples are weighted by catch periods rather than structured weekly periods, unbiased age compositions are obtained.

PART B

In 1989, 56 licenses were issued (as of October 31, 1989) although only 41 tip trap sites were actually fished. Landings of gaspereau from the Margaree River fishery for 1950 to 1989 are presented in Table 7. The 1989 catch for Margaree, estimated at 1,123 metric tons, is similar to the 5 year average but exceeded the upper 95% confidence interval of the historical (40 years), mean for District 2 (Table 7). Relative to gaspereau fisheries within Gulf Region, the Margaree fishery remains the dominant stock exploited in Nova Scotia and represents approximately 15 to 38% of the total landings from the Gulf (Table 8).

1989 Fishery

Based upon logbook reports, the largest daily catch occurred on May 18, when 172 tons of gaspereau were landed (18% of total logbook catch). The date of 50% catch was May 19 which is very similar to previous years and provides further evidence of the predictable migration timing (within one week) of alewife into Margaree River (Table 9). The fishery was conducted over a very

short period of time, 80% of the catch was landed over a period of 10 days, the shortest interval ever (Table 9).

The 1989 gaspereau catch was estimated to consist of **99.5%** alewife by weight. This is similar to previous year fisheries and consequently a blueback herring assessment has not been provided. Catch at age matrix of blueback herring is presented in Table 10.

Catch at Age Matrices

The catches at age for alewife are presented, by age of recruitment, for the years 1983 to 1989 (Table 11). The catch vector for 1989 was calculated from the stratified samples by zone, using catch period interval keys.

The 1985 year class was the dominant component of the alewife catch in 1989 (87% by number). Percent new recruits was about average to the previous 6 years but would have been substantially higher had the 1986 year class (3 year old new recruits) not been such a minor component of the overall catch (Table 11). The contribution by the 3 year old fish (2.9% by number) was the lowest in the past 7 years, previous low was in 1985 (9.2%) while the highest contribution by that age group was recorded in 1987 (79% of total) (Table 11). The previously dominant 1984 year class continued to contribute significantly to the catch, accounting for almost 9% by number (Table 11).

Weight at Age Matrix

The weight at age matrix for alewife for 1983 to 1989 is presented in Table 12. In all years, mean weights at age were calculated using the measured weights of individual fish. The weight at age vector used in yield per recruit analysis was the weighted mean of all years, 1983 to 1989.

ABUNDANCE INDEX

In the previous assessment, an abundance index was calculated from the index trap catch based on effort for the 5% to 95% cumulative catch interval. In 1989, the index trap was not representative of the daily catch trend of the river. This index was therefore considered inappropriate for 1989. A new index based upon catch rates from logbook reports from the entire river was constructed using a multiplicative model approach (Gavaris 1980). The catch and effort data from the logbooks were treated in the following manner.

1) The 10 to 90% catch interval for the entire river was identified and catches outside the interval were eliminated. This was done to remove the effect of scouting and opportunistic fishing towards the end of the season. As well, bluebacks which enter the river in the latter part of the season would not be considered in the analysis.

2) Catch per unit effort was calculated as the quotient of total catch (kg) to total effort (days) for each trap during the catch interval estimated in Step 1. Natural log of catch per unit effort was the dependent variable.

The catch rate model was fitted using SAS GLM procedures and model diagnostics were obtained using SAS REG procedures (SAS 1985). These diagnostics included leverage estimates (diagonal of the Hat matrix) and influential statistics using Cook's D and the DFFITS calculation which estimates the change in the parameter coefficients when an observation is left out relative to when the observation is included in the model. Cumulative probability plots of residuals were used to assess the normality of the residuals. These procedures are described by Neter et al. (1983) and Freund and Littell (1986). The abundance index was estimated from the model solutions to the year variable using the transformation equation described by Gavaris (1988) which corrects for the standard errors of the coefficients.

Parameters which were considered potentially important in explaining the variance in catch rates over time were zone on the river (lower vs upper) and total effort expended during the year by individual traps (i.e. opportunists fishing < 10 days in any year, moderates fishing between 10 and 17 days per year and extremists fishing > 17 days per year).

The year variable, by itself, explained less than 11% of the total variance of the catch rates. The fishing effort category added to the model containing year increased the R-square to 0.12. Addition of the zone variable to the model containing year increased the R-square to 0.26 and it was kept. Influence diagnostics of the model containing the year and zone parameters after several steps resulted in the deletion of 10 of the original 164 from the model and a final R-square of 0.34 (Table 13). Normal probability plot of the residuals confirmed the normality assumption (Fig. 5). Influence diagnostics of this final model did not reveal any observations with high DFFITS values (Fig. 6). The 1983 observations did have high leverage values but individually had low influence as seen from the plot of Cook's D statistic (Fig. 6). Transformed catch rates (tons/day) were:

1983	2.50
1984	2.36
1985	5.03
1986	2.57
1987	4.47
1988	5.33
1989	4.18

The abundance indices from the catch rate model and from the previous assessment are summarized in Fig. 7. The abundance indices give a different pattern of abundance of gaspereau during 1983 to 1989.

NATURAL MORTALITY

A composite non-inriver fishing mortality component, calculated as Mc = 0.44 for alewife during the first spawning migration and Mc = 1.05 for subsequent spawning years (Chaput and Alexander 1989) was used.

COHORT ANALYSIS

Cohort analysis was performed under Type I fishery assumptions, i.e. the natural mortality occurs at a time of year other than the fishing season and the population decreases during the fishing season as a result of catch removals only. For convenience, the biological year begins when the fishing commences and natural mortality occurs after fishing ends (Ricker 1975: p. 10-11). The cohort model utilized in this document uses a modification of the catch equations documented by Rivard (1982). Specifically, population numbers of the last age group are considered equal to the catch with fishing complete. The population numbers refer to numbers just prior to the beginning of the fishery. Cohort analysis of the alewife population was performed on two groups separately based upon the age of recruitment. This type of analysis eliminates the requirement of a partial recruitment vector since in each simulation, all the fish included are fully recruited to the fishery. Two groups were analyzed for Margaree, age 3 recruits and age 4 recruits. Alewife, aged as 2 and 5 year old recruits, constitute a minor component of the population and are not considered.

Because population of the oldest age equals catch of the oldest age, this cohort analysis ignores oldest age group F's encountered in other SPA models. The terminal F values were determined iteratively by regressing population biomass at F against the index of abundance (intercept model) and selecting the F from a combination of high R-square value and intercept term close to the origin. A final cohort analysis was performed using the selected terminal F to generate estimated population numbers at the beginning of the fishery. A summary of the calibration sequence is presented in Fig. 8. Population numbers and estimated F values are presented in Table 14.

Total river returns in 1989 were estimated at 7.593 million fish, the third highest estimated number since 1983 (Table 14). Returns were dominated by 4 year old new recruitment, second highest since 1983 whereas 3 year old recruitment was the lowest estimate to date. The 1984 year class continued to provide significant quantities of fish, 0.67 million, to the river returns and should be present in detectable quantities next year. Retrospective analysis of predicted year class size from the 1988 assessment (Chaput and LeBlanc 1989) relative to current year estimates, indicated that the size of the 1984 year class was previously overestimated by almost 10% (Fig. 9). The 1985 year class has been estimated this year as approximately one-third larger than previously estimated. Converged year classes (1980, 1981, and 1982) showed little change in numbers from the previous year, in spite of having used different abundance indices in the two years.

Predictions of new recruitment for the 1989 fishery, based on mean recruitment values of the previous years were wrong. The estimated strength of

the 3 year new recruitment (1986 cohort) was 7% of predicted whereas the 4 year old new recruitment (1985 cohort) was almost 4 times larger. Total recruitment numbers were closer, 4,656,000 estimated versus 4,130,000 predicted. The prefishery population numbers of previous spawners was 2,900,000 versus 1,983,000 predicted. Estimated catch in 1989 was within the 90% confidence interval (693 to 1533 t) of the predicted catch at F = 1.0.

YIELD PER RECRUIT - $F_{0.1}$

A yield per recruit analysis by the method of Thompson and Bell (Rivard 1982) was performed for alewife by age of recruitment, under the assumptions of Type I fisheries and using the Mc values mentioned previously. The results are summarized below:

Recruited age	$F_{0.1}$	Yield per Recruit	Avg. Weight	Interval of Estimate
Mc = 0.44, 1.05				
3	1.01	0.182	0.225	3 to 9
4	1.03	0.223	0.275	4 to 10

Under Type II assumptions, yield per recruit analysis generated the following results:

3	1.32	0.158	0.220	3 to 9
4	1.35	0.195	0.270	4 to 10

The $F_{0.1}$ value of F calculated using the variable composite mortality under Type I assumptions is substantially smaller than that estimated under Type II assumptions. Fishing mortalities for 3 and 4 year old recruited alewife are close to or higher than the $F_{0.1}$ estimate. Fishing mortalities generally exceed the $F_{0.1}$ value for 4 year old recruits. Previous F's of 0.95 and 1.0 for the 1988 fishery were underestimated which explains the reduction in estimated numbers in the population for most cohorts.

PROGNOSIS

An analysis of the population numbers generated with the cohort analysis and estimates of harvest at F = 1.0 ($F_{0.1}$ value) are presented in Table 15. The estimated landing for 1990 of 864 metric tons is based in large part upon a seven year mean of 3 and 4 year old recruitment, which would account for 58% of the anticipated landing. The Margaree alewife stock has provided large landings in the past three years, exploiting a strong 1984 year class and a 1985 year class which appears to be stronger than average. The 1985 year class will

be a significant component of the 1990 landings. The ratio of 3 year old recruits to 4 year old recruits for a cohort has always been greater than 1 (Table 14). If this pattern is consistent for the 1986 year class, then 4 year old fish in the 1990 fishery should be rare indeed and the landing for 1990 could be substantially lower than predicted based upon the 7 year mean of 4 year old recruits. The fishery continues to exploit the resource at and occasionally higher than $F_{0.1}$ value. Given the high exploitation rate on this resource and the predicted weakness of the 1986 year class, fishing effort on the river should not be increased from present levels and staggered weekly closures should be maintained.

REFERENCES

Alexander, D.R. 1984. Status of the Margaree River gaspereau fishery (1983). CAFSAC Res. Doc. 84/87. 14 p.

Alexander, D.R. and A.H. Vromans. 1985. Status of the Margaree River gaspereau fishery (1984). CAFSAC Res. Doc. 85/91. 17 p.

Alexander, D.R. and A.H. Vromans. 1986. Status of the Margaree River gaspereau fishery (1985). CAFSAC Res. Doc. 86/31. 17 p.

Alexander, D.R. and A.H. Vromans. 1987. Status of the Margaree River gaspereau fishery (1986). CAFSAC Res. Doc. 87/18. 16 p.

Alexander, D.R. and A.H. Vromans. 1988. Status of the Margaree River alewife (Alosa pseudoharengus) fishery 1987. CAFSAC Res. Doc. 88/25. 25 p.

Cating, J.P. 1953. Determining age of Atlantic shad from their scales. U.S. Fish and Wildlife Ser., Fish. Bull. 54 (85):187-199.

Chaput, G.J. and D.R. Alexander. 1989. Mortality rates of alewife in the Southern Gulf of St. Lawrence. CAFSAC Res. Doc. 89/38. 23 p.

Chaput, G.J. and C.H. LeBlanc. 1989. Assessment of the Margaree River gaspereau fishery, 1988. CAFSAC Res. Doc. 89/29. 29 p.

Freund, R.J. and R.C. Littell. 1986. SAS System for Regression 1986 Edition. SAS Institute Inc., Cary, NC. 165 p.

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37:2272-2275.

Gavaris, S. 1988. Abundance indices from commercial fishing. In: D. Rivard (ed.) Collected papers on stock assessment methods. CAFSAC Res. Doc. 88/61.

Gavaris, S. and C.A. Gavaris. 1983. Estimation of catch at age and its variance for groundfish stocks in the Newfoundland Region. Can. Spec. Publ. Fish. Aquat. Sci. 66:178-182.

Neter, J., W. Wasserman and M.H. Kutner. 1983. Applied Linear Regression Models. Irwin, Homewood, Illinois. 547 p.

Ricker, W.E. 1975. Computation and interpretation of biological statistics in fish populations. Bull. Fish. Res. Board Can. No. 191:382 p.

Rivard, D. 1982. APL programs for stock assessment. Can. Tech. Rep. Fish. Aquat. Sci. No. 1091. 146 p.

SAS. 1985. SAS User's Guide: Statistics. Version 5 Edition. SAS Institute Inc., Cary, NC. 956 p.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. No. 184. 966 p.

Smith, S.J. and J.J. Maguire. 1983. Estimating the variance of length composition samples. Can. Spec. Publ. Fish. Aquat. Sci. 66:165-170.

Wright, J. 1990. AGELEN -- A system of programs for computing estimates of age and length distributions in fish populations. Can. Tech. Rep. Fish. Aquat. Sci. (In prep.).

Table 1. Locations, dates and periods sampled during the 1989 Margaree River gaspereau fishery. Site numbers are indicated in Figure 1.

		Lower			Upper				
		Site #	Period	No. Meas.	Site #	Period	No. Meas.	Site 12 Random	Julian Date
	May 1								121
	2								122
	3								123
	4							25	124
	5								125
Saturday	6								126
Sunday	7							24	127
	8	8	AM	300				25	128
	9	5	PM	299	49	AM	160	25	129
	10	9	AM	302	46	PM	129	23	130
	11	25	AM	283	33	AM	327		131
	12	2	AM	288	49	AM	313	25	132
Saturday	13				35	AM	309		133
					35	PM	263		
Sunday	14	12	AM	346				25	134
		12	PM	216					
	15	17	PM	258	39	PM	307	24	135
	16	5	PM	300	38	PM	305	24	136
	17	8	AM	301	33	AM	301		137
	18	9	PM	305	49	PM	300	25	138
	19	7	AM	310	37	PM	303		139
Saturday	20				38	AM	301		140
					51	AM	300		
Sunday	21	2	AM	226				25	141
		8	PM	314					
		11	AM	300					
	22	25	PM	300	64	PM	308	25	142
	23	9	PM	300	35	PM	300	25	143
	24	12	AM	306	33	AM	306	25	144
	25				64	AM	303	25	145
	26							24	146
Saturday	27				33	AM	340		147
Sunday	28							25	148
	29							25	149
	30	12	PM	375				25	150
	31	5	AM	130	56	PM	135	25	151
	June 1				64	PM	287	25	152
	2	12	AM	64	33	AM	108	24	153
Saturday	3								154
Sunday	4							25	155
	5							25	156
	6	15	AM	270				25	157
	7	17	PM	205	64	PM	195	24	158
	8				64	PM	83	23	159
	9	15	AM	250					160
Saturday	10								161
Sunday	11								162
Number of gaspereau measured				6548			5983	665	

Table 2. Number of gaspereau aged by species from the stratified samples and the random samples, Margaree River, 1989. Age.fsp refers to total age followed by age of first recruitment to the river.

Species age.fsp	Stratified Sampling			Historical
	Lower	Upper	Combined	Random
Alewife				
2.2	8	15	23	3
3.3	77	96	173	18
4.3	254	240	494	128
4.4	443	468	911	302
5.3	71	77	148	24
5.4	70	65	135	44
5.5	2		2	
6.3	3	9	12	2
6.4	9	12	21	4
7.4	3		3	1
Blueback				
4.3	2	1	3	1
4.4	22	17	39	18
5.3	2	2	4	3
5.4	97	94	191	91
5.5	37	34	71	22
6.3		1	1	
6.4	6	4	10	2
6.5	2	2	4	1
7.4	1	1	2	
7.5		1	1	
Total	1109	1139	2248	664

Table 3. Intratrap variation of estimated percent at age of alewife, Margaree River, 1989. Age.fsp refers to total age and age of first spawning. AM & PM refer to morning and afternoon sampling periods, combined refers to samples from AM & PM combined. Site 12 is a lower zone trap, site 35 is from the upper zone. Asterisk (*) indicates differences in proportion at age between AM, PM samples and combined samples.

	Site 12		Site 35	
Age.fsp	AM	PM	AM	PM
Alewife				
3.3	0.29	-	5.18	5.70
4.3	40.58	18.98 *	22.65	23.19
5.3	8.41	17.97 *	33.01	17.11 *
6.3	1.74	-	-	6.46 *
4.4	39.71	56.89 *	28.80	31.18
5.4	6.09	5.99	5.83	12.55 *
6.4	3.19	0.46	4.53	3.80
7.4	-	-	-	-
5.5	-	-	-	-
Chi-square		47.3		42.4
df		6		6
P-value		<0.001		<0.001
Sample size	346	216	309	263

Table 4. Intertrap variation of estimated percent at age of alewife, Margaree River, 1989. Age.fsp refers to total age and age of first spawning. AM & PM refer to morning and afternoon sampling periods, combined refers to samples from all sites combined. Asterisk (*) indicates differences in proportion at age between site samples and combined site samples.

	Lower Zone			Upper Zone	
Age.fsp	2	8	11	38	51
Alewife					
3.3	1.33	1.28	0.33	1.66	0.00
4.3	40.71	11.50	19.40 *	42.19	38.33
5.3	2.21	1.28	0.00	4.32	4.33
6.3	-	-	-	-	-
4.4	54.42	85.94	77.93 *	50.17	29.00 *
5.4	1.33	0.00	2.34 *	1.66	28.33 *
6.4	-	-	-	-	-
7.4	-	-	-	-	-
5.5	-	-	-	-	-
Chi-square		85.47			94.46
df		8			4
P-value		<0.001			<0.001
Sample size	226	314	300	301	300

Table 5. Percent by number at age of alewife and blueback by management zone in the 1989 Margaree River gaspereau fishery estimated using different age-length key sample combinations. Asterisk (*) indicates significant differences (P<0.05) between lower and upper zone proportions.

	Percent at age					
	Catch Period		Weekly		Twice Weekly	
AGE.FSP	Lower	Upper	Lower	Upper	Lower	Upper
Alewife						
2.2	0.01	0.02	0.02	0.02	0.01	0.03
3.3	2.81	2.86	3.00	3.70	2.79	2.42
4.3	27.32	31.82	27.82	30.60	27.77	31.90
5.3	4.89	3.33	6.89	2.85 *	6.74	3.03 *
6.3	0.09	0.23	0.17	0.31	0.08	0.18
4.4	58.45	56.31	53.48	57.27	54.37	57.78
5.4	4.76	3.80	5.85	3.67	6.29	3.32 *
6.4	0.27	0.25	0.48	0.43	0.31	0.42
7.4	0.01	0.00	<.01	0.00	0.01	0.00
5.5	0.06	0.00	0.05	0.00	0.04	0.00
Blueback						
4.3	0.01	0.01	0.01	0.02	0.01	0.02
5.3	<.01	0.02	0.01	0.01	0.01	0.01
4.4	0.11	0.15	0.19	0.14	0.14	0.12
5.4	0.83	0.83	1.33	0.65	0.78	0.51
6.4	0.00	0.03	0.04	0.02	0.02	0.03
7.4	0.01	<.01	<.01	<.01	<.01	<.01
5.5	0.35	0.31	0.64	0.29	0.63	0.21
6.5	0.03	0.02	0.02	0.01	0.01	0.01
7.5	<.01	<.01	0.00	<.01	0.00	<.01
Sample size	1000	1000	1000	1000	1000	1000
Chi-square		9.66		30.09		31.40
df		10		9		9
P-value		>0.05		<0.01		<0.01
Percent by number						
Alewife	98.7	98.6	97.8	98.9	98.4	99.1
Blueback	1.3	1.4	2.2	1.1	1.6	0.9

Dates (Julian) corresponding to periods used in age-length key aggregations

Period 1	<134	<135	<133	<134	<130	<131
					130-132	131-133
2	134-137	135-137	134-139	135-140	134-136	135-137
					137-139	138-140
3	138-142	138-143	141-146	142-147	141-143	142-144
					144-146	145-147
4	143-148	144-147	148-153	149-154	148-150	149-151
					151-153	152-154
5	>148	>147	>154	>155	155-157	156-158
					>157	>158

Table 6. Percent at age and coefficient of variation of alewife and blueback in the 1989 Margaree River gaspereau fishery estimated using different age-length key sample combinations for two-stage stratified sampling and historical random sampling strategies.

	Two-Stage Stratified Sampling						Historical Random Sampling					
	Percent at Age			Coefficient of Variation			Percent at Age			Coefficient of Variation		
Age.fsp	Catch Period	Weekly	Twice Weekly	Catch Period	Weekly	Twice Weekly	Index Trap	Lower Zone	River	Index Trap	Lower Zone	River
Alewife												
2.2	<.01	0.02	0.02	93.8	>100	>100	0.15	0.02	0.03	-	-	-
3.3	2.83	3.28	2.64	14.2	11.7	16.9	1.04	2.24	2.56	23.7	81.3	81.6
4.3	29.12	28.94	29.43	2.6	2.6	3.4	27.32	32.30	31.56	12.4	13.9	15.5
5.3 @	4.27	5.25	5.25	9.3	8.7	11.9	2.40	1.96	1.64	45.3	43.9	39.3
6.3	0.15	0.23	0.12	71.5	72.6	>100	0.10	0.03	0.05	76.1	77.4	22.9
4.4	57.60	55.01	55.75	1.5	1.6	2.1	55.54	51.78	52.94	6.5	7.5	7.8
5.4 @	4.37	4.97	5.09	8.5	9.3	11.9	7.40	8.95	8.90	29.2	30.2	32.7
6.4	0.26	0.46	0.35	49.4	46.7	51.3	0.83	0.69	0.74	25.5	64.0	62.9
7.4	<.01	<.01	<.01	>100	>100	>100	0.00	0.00	0.00	-	-	-
5.5	0.03	0.03	0.02	41.4	41.5	66.0	0.00	0.00	0.00	-	-	-
Blueback												
4.3	0.01	0.01	0.01	42.2	50.0	72.0	0.04	0.05	0.02	>100	>100	>100
5.3	0.01	0.01	0.01	27.2	65.7	>100	0.11	0.03	0.02	59.6	67.1	64.9
4.4	0.12	0.17	0.13	10.5	13.1	16.9	0.90	0.31	0.45	30.1	32.6	54.7
5.4	0.83	1.05	0.67	2.9	4.5	5.6	3.33	1.20	0.84 *	9.4	10.3	10.7
6.4	0.03	0.03	0.03	24.6	42.2	55.4	0.07	0.03	0.01	55.9	36.5	23.6
7.4	<.01	<.01	<.01	89.4	>100	>100	0.00	0.00	0.00	-	-	-
5.5	0.33	0.50	0.44	5.0	6.9	8.7	0.72	0.40	0.21	24.1	23.2	25.4
6.5	0.02	0.02	0.01	24.4	56.7	91.3	0.04	0.02	0.02	>100	>100	>100
7.5	<.01	<.01	<.01	-	>100	>100	0.00	0.00	0.00	-	-	-
Sample size	1000	1000	1000				1000	1000	1000			
Chi-square		5.39						46.29				
d.f.		36						24				
P-value		>0.05						<0.01				
Percent by number												
Alewife	98.63	98.19	98.67				94.78	97.96	98.42			
FSP	60.5	58.3	58.4				56.7	54.0	55.5			
PREV	38.2	39.9	40.2				38.1	43.9	42.9			
Blueback	1.35	1.79	1.32				5.22	2.04	1.58			
FSP	0.45	0.67	0.59				1.6	0.7	0.7			
PREV	0.89	1.12	0.73				3.6	1.3	0.9			

* significant difference ($P<0.05$) in proportions at age estimated with the three weighting schemes for the random samples.
@ significant difference ($P<0.05$) in proportions at age estimated from the stratified samples (catch period weighting) and the random sampling (lower zone weighting).

Table 7. Gaspereau landings from District 2 and Margaree River, 1950 to 1989. Historical, recent 10 year and 5 year means (95% confidence intervals) are also presented.

	Landings (mt)	
Year	District 2	Margaree River only
1950	713	
1951	755	
1952	964	
1953	638	
1954	1,275	
1955	1,163	
1956	859	
1957	58	
1958	395	
1959	496	
1960	531	
1961	423	
1962	558	
1963	551	
1964	640	
1965	875	
1966	320	
1967	185	
1968	188	
1969	251	
1970	408	
1971	620	
1972	965	
1973	1,113	
1974	1,681	
1975	1,238	
1976	497	
1977	1,202	
1978	1,713	
1979	1,776	
1980	1,069	
1981	1,369	
1982	1,445	
1983	580	
1984	883 *	883 *
1985	1,223 *	1,223 *
1986	545 *	545 *
1987	1,259 *	1,259 *
1988	1,912	1,666 *
1989	1,123 *	1,123 *
Means (95% C.I.)		
Historical	855 (702-1,007)	
10 Year	1,206 (902-1,510)	
5 Year	1,164 (600-1,729)	1,115 (645-1,761)

* Science Branch estimates. All other values are from Statistics Branch.

Table 8. Landings of gaspereau for the Gulf Region, 1978 to 1988. Data summarized from purchase slip and Supp. "B" slips collated by Statistics Branch, DFO.

	Nova Scotia Statistical District							Total Landings (metric tons)			
Year	2	3	11	12	13	45	46	NS	NB	PEI	Gulf
1978	1,712.7	4.9	36.3	6.8	32.4	117.9	0.0	1,911.0	3,084.1	104.2	5,099.3
1979	1,776.1	0.2	114.4	9.1	49.4	74.3	0.0	2,023.4	4,408.7	405.3	6,837.4
1980	1,069.3	0.0	909.7	21.2	79.8	75.5	11.8	2,167.4	4,676.0	253.2	7,096.5
1981	1,368.6	0.7	61.2	12.7	77.6	103.1	29.5	1,653.5	2,708.0	258.8	4,620.3
1982	1,445.5	0.0	29.4	18.2	34.4	115.4	20.6	1,663.6	1,993.7	132.9	3,790.2
1983	579.8	0.0	144.1	27.2	16.0	10.2	2.5	779.8	1,900.6	36.4	2,716.9
1984	883.0 *	0.0	77.5	6.8	84.7	0.2	0.1	1,052.4	1,716.9	87.9	2,857.2
1985	1,223.0 *	0.0	0.0	1,854.2	99.6	26.4	0.0	3,203.3	3,569.2	238.4	7,010.9
1986	545.0 *	0.0	161.4	31.8	236.2	0.0	0.0	974.3	2,261.3	463.6	3,699.3
1987	1,259.0 *	0.0	847.5	59.1	127.6	121.6	143.7	2,558.6	4,419.2	364.2	7,342.0
1988	1,911.8	-	570.2	120.0	224.5	-	8.4	2,835.0	3,713.7	233.2	6,782.1
Mean	1,252.2	0.5	268.3	197.0	96.6	58.6	19.7	1,892.9	3,132.0	234.4	5,259.3

* District 2 1984-1987 landings as per DFO Science Branch estimate (see Table 7).

Table 9. Catch, effort and dates of maximum and cumulative landings for the gaspereau fishery of the Southwest Margaree River, 1983 to 1989.

	1983	1984	1985	1986	1987	1988	1989
Logbook: effort (hrs)	2,010	7,498	3,306	3,283	4,374	8,046	
catch (mt)	112.65	637.07	506.37	212.69	882.27	1375.08	972.70
Estimated Landings (mt)	579.82	883.41	1222.70	545.20	1258.80	1665.70	1123.00
Expansion Factor	5.1471	1.3867	2.4146	2.5634	1.4268	1.2113	1.1545
Estimated Effort (hrs)	10,346	10,397	7,983	8,416	6,241	9,747	
Landings							
Date of: Maximum catch	May 17	May 17	May 30	May 17	May 13	May 22	May 18
Cumulative 10%	10	16	21	9	12	17	14
50%	17	21	28	17	16	23	19
90%	24	28	June 2	26	26	29	23
Total days for 10% to 90%	15	12	12	17	15	13	10

Catch timing values for 1983 to 1988 were corrected from those presented by Chaput and LeBlanc (1989) who reported the 5% to 95% cumulative catch period.

Table 10. Catch at age (numbers) of blueback herring in the Southwest Margaree River gaspereau fishery, 1983 to 1989. AGE.FSP refers to total age followed by age of recruitment.

AGE.FSP	1983	1984	1985	1986	1987	1988	1989
1.1	0	42	0	0	0	0	0
2.2	0	0	0	0	0	0	0
3.2	0	1,093	1,419	0	0	0	0
4.2	0	716	2,943	0	0	0	0
5.2	0	666	72	0	0	0	0
3.3	0	51	138	169	675	2,152	0
4.3	0	4,229	10,919	87	0	5,475	341
5.3	0	3,012	3,619	237	0	0	597
6.3	6,290	1,501	0	614	52	0	0
7.3	0	0	0	105	597	0	0
8.3	0	0	1,353	0	0	0	0
9.3	0	0	0	0	0	0	0
4.4	0	0	7,115	668	1,946	24,956	5,176
5.4	0	16	1,775	1,499	77	1,765	35,141
6.4	6,290	28	7,165	699	1,814	0	1,244
7.4	0	0	0	248	103	0	114
8.4	0	0	0	0	597	0	0
9.4	164	446	0	0	0	0	0
10.4	164	0	0	0	0	0	0
5.5	0	0	0	0	0	0	14201
6.5	0	0	0	0	0	0	654
7.5	0	0	0	0	0	0	28
Total Catch	12,908	11,800	36,518	4,326	5,861	34,348	57,496

Table 11. Estimated numbers of alewife by total age and age of recruitment in the gaspereau fishery, Southwest Margaree River, 1983 to 1989. %FSP refers to percent new recruitment.

Numbers of alewife	Year						
Total Age	1983	1984	1985	1986	1987	1988	1989
Recruited at age 2							
2	0	0	24,806	2,104	0	0	657
3	1,759	0	106,971	15,683	0	0	0
4	0	0	0	0	9,936	0	0
5	0	0	0	0	0	0	0
Recruited at age 3							
3	713,210	2,600,587	446,784	1,262,253	4,400,237	2,479,427	120,091
4	397,393	258,404	920,280	158,545	429,356	2,354,640	1,235,744
5	334,105	185,480	40,614	129,007	18,600	160,274	181,065
6	52,414	4,211	27,024	5,818	4,607	6,993	6,235
7	17,976	1,090	2,937	0	0	0	0
8	2,733	644	0	0	0	0	0
9	5,248	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Recruited at age 4							
4	370,661	428,329	3,069,913	235,293	433,678	1,431,033	2,444,088
5	156,504	35,124	204,850	371,931	130,546	267,326	185,607
6	45,417	20,213	6,467	10,649	181,210	69	11,078
7	0	4,112	0	3,888	0	0	38
8	2,733	4,409	1,343	0	0	0	0
9	0	43,447	0	0	0	0	0
10	0	248	0	0	0	0	0
11	0	0	0	0	0	0	0
Recruited at age 5							
5	0	0	0	0	0	0	1,434
6	5,248	1,239	875	6,529	0	0	0
7	0	0	0	0	0	0	0
Total	2,105,400	3,587,536	4,852,865	2,201,700	5,608,169	6,699,762	4,186,037
% FSP	51.5	84.4	73.0	68.1	86.2	58.4	61.3
Dominant Year-class	1979	1981	1981	1983	1984	1984	1985
% of total	36.5	72.5	82.2	58.0	78.5	56.5	87.9

Table 12. Mean weight (g) at age for alewife in the Southwest Margaree gaspereau fishery.

	1983	1984	1985	1986	1987	1988	1989
2	-	-	164	152	-	-	137
3	220	210	210	215	211	214	188
4	289	288	250	264	252	261	265
5	308	349	321	303	294	303	310
6	322	376	348	358	347	339	357
7	352	407	405	412	-	411	406
8	375	403	397	-	-	-	-
9	356	446	455	-	-	-	-
10	-	478	-	-	-	-	-
6+	340	381	381	363	346	353	362
7+	357	389	415	412	-	411	406

Table 13. Results of multiplicative model using natural log of kg per days fished per trap in lower and upper zones, 1983 to 1989. This model uses all logbook reports during the 10 - 90 % catch interval for each season.

GENERAL LINEAR MODELS PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
YY	7	83 84 85 86 87 88 89
ZONE	2	0 1

NUMBER OF OBSERVATIONS IN DATA SET = 154

DEPENDENT VARIABLE: LOGKG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F
MODEL	7	36.65099902	5.23585700	10.71	0.0001
ERROR	146	71.39191919	0.48898575		
CORRECTED TOTAL	153	108.04291821			

R-SQUARE	0.339226
ROOT MSE	0.69927516
MEAN LOGKG	0.56313378
C.V.	9.2458

SOURCE	DF	TYPE III SS	F VALUE	PR > F
YY	6	16.12853968	5.50	0.0001
ZONE	1	16.97917546	34.72	0.0001

PARAMETER		ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT		7.40128473 B	56.74	0.0	0.13043195
YY	83	-0.46773373 B	-1.39	0.1655	0.33558221
	84	-0.56905134 B	-3.35	0.0010	0.16993676
	85	0.20500082 B	0.84	0.4013	0.24356302
	86	-0.46290286 B	-1.83	0.0699	0.25347240
	87	0.07477703 B	0.39	0.6990	0.19300819
	88	0.24650106 B	1.48	0.1407	0.16642173
	89	0.00000000 B	.	.	.
ZONE	LOWER	0.70076553 B	5.89	0.0001	0.11892209
	UPPER	0.00000000 B	.	.	.

SUM OF RESIDUALS	-1.42109E-13
SUM OF SQUARED RESIDUALS	71.39192
PREDICTED RESID SS (PRESS)	77.79121

Table 14. Prefishery population numbers of alewife and values of F by recruitment age, estimated from Type I cohort analysis.

	Year						
Age	1983	1984	1985	1986	1987	1988	1989
Total River Returns	3,895,766	6,314,647	6,983,599	4,479,014	11,747,012	11,722,541	7,592,794
Recruited at age 3							
3	1,368,414	4,660,344	864,157	2,719,126	9,515,256	5,963,824	218,081
4	1,172,097	421,975	1,326,559	268,803	938,279	3,294,258	2,244,078
5	351,094	271,098	57,240	142,172	38,584	178,091	328,808
6+	78,371	5,945	29,961	5,818	4,607	6,993	6,235
3+	2,969,976	5,359,362	2,277,917	3,135,919	10,496,726	9,443,166	2,797,202
Fishing Mortality							
3	0.74	0.82	0.73	0.62	0.62	0.54	0.80
4	0.41	0.95	1.18	0.89	0.61	1.25	0.80
5	3.03	1.15	1.24	2.38	0.66	2.30	0.80
6+	-	-	-	-	-	-	-
3+	0.89	0.84	1.01	0.73	0.62	0.82	0.80
Population number recruited at age 4							
4	503,192	793,664	4,451,472	438,781	938,019	1,954,382	4,438,381
5	225,233	85,354	235,289	889,774	131,053	324,814	337,056
6	194,632	24,051	17,578	10,652	181,213	178	20,117
7+	2,733	52,216	1,343	3,888	1	1	38
4+	925,790	955,285	4,705,682	1,343,095	1,250,286	2,279,375	4,795,592
Fishing Mortality							
4	1.33	0.78	1.17	0.77	0.62	1.32	0.8
5	1.19	0.53	2.05	0.54	5.55	1.73	0.8
6	0.27	1.84	0.46	8.22	11.06	0.49	0.8
7+	-	-	-	-	-	-	-
4+	1.07	0.79	1.21	0.68	2.65	1.38	0.80

Table 15. Predicted potential landing of alewife in the Margaree River fishery in 1990 at sustained F = 1.0. Prediction inferred from population numbers generated from Type I cohort analysis.

Year Class	Prefishery Population 1989	Catch 1989	Composite Mortality Removals		Prefishery Population 1990	Catch (F=1.0)	Landed Weight (Tons)
Recruited at age 3				(Mc=)			
1986	218081	120091	34881	(0.44)	63109	39893	10.5
1985	2244078	1235744	655480	(1.05)	352854	223046	70.9
1984	328808	181065	96042	(1.05)	51701	32681	11.7
1983	6235	6235	0	(1.05)			
Recruited at age 4							
1985	4438381	2444088	709896	(0.44)	1284397	811894	258.2
1984	337056	185607	98451	(1.05)	52998	33501	12.0
1983	20117	11078	5876	(1.05)	3163	1999	0.7
1982	38	38	0	(1.05)			
Without new recruitment						Metric Tons	363.9
With new recruitment - mean				age 3	2108781	1333004	283.9
				age 4	1302124	823099	215.7
					Expected Landing		863.5
					(90% C.I.)		(583 to 1463)

Age 3 and 4 new recruitment based upon 7 year geometric mean of 1983 to 1988 population recruited as per cohort analysis.

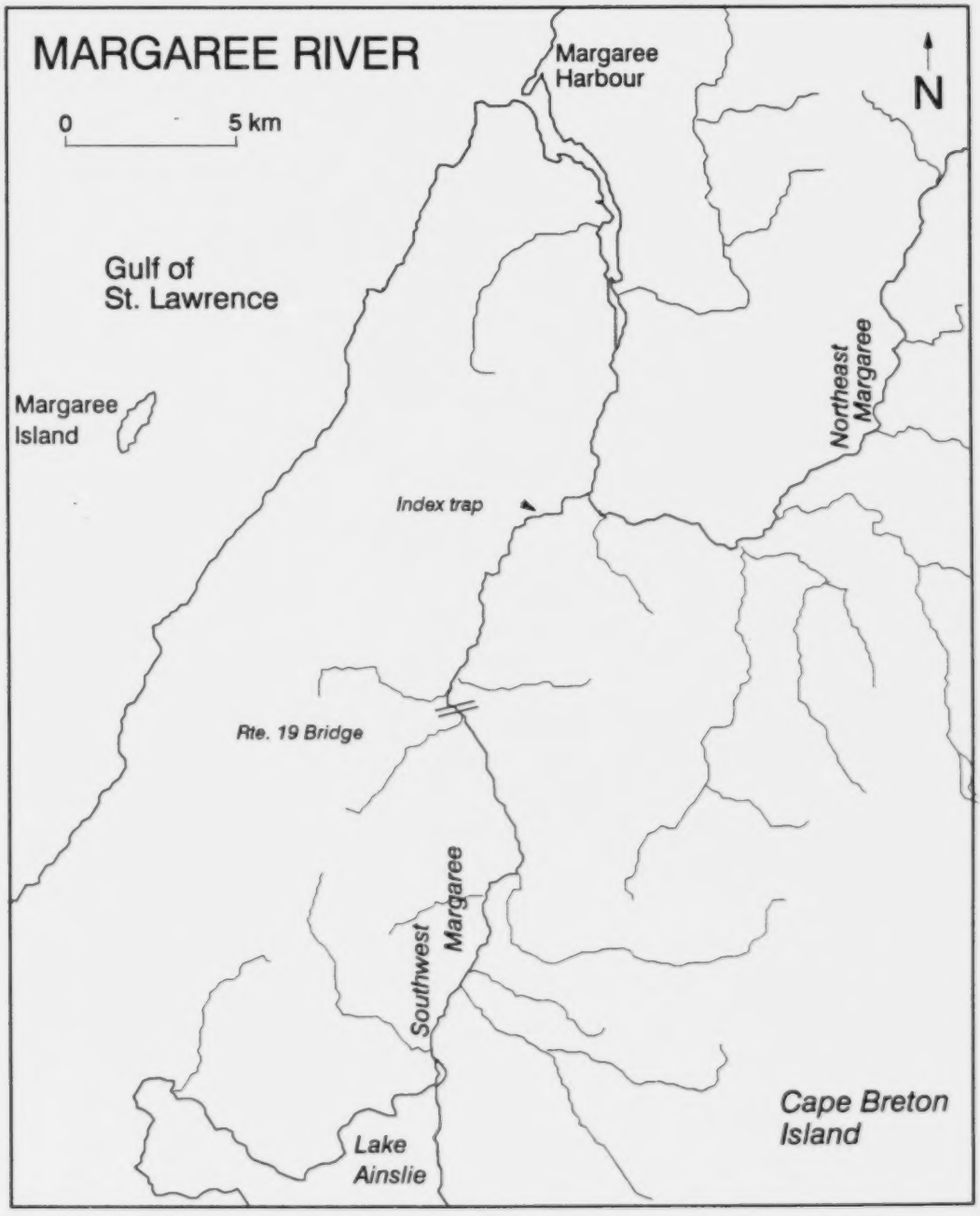

Fig. 1 Margaree River, showing management zones and location of historical index trap.

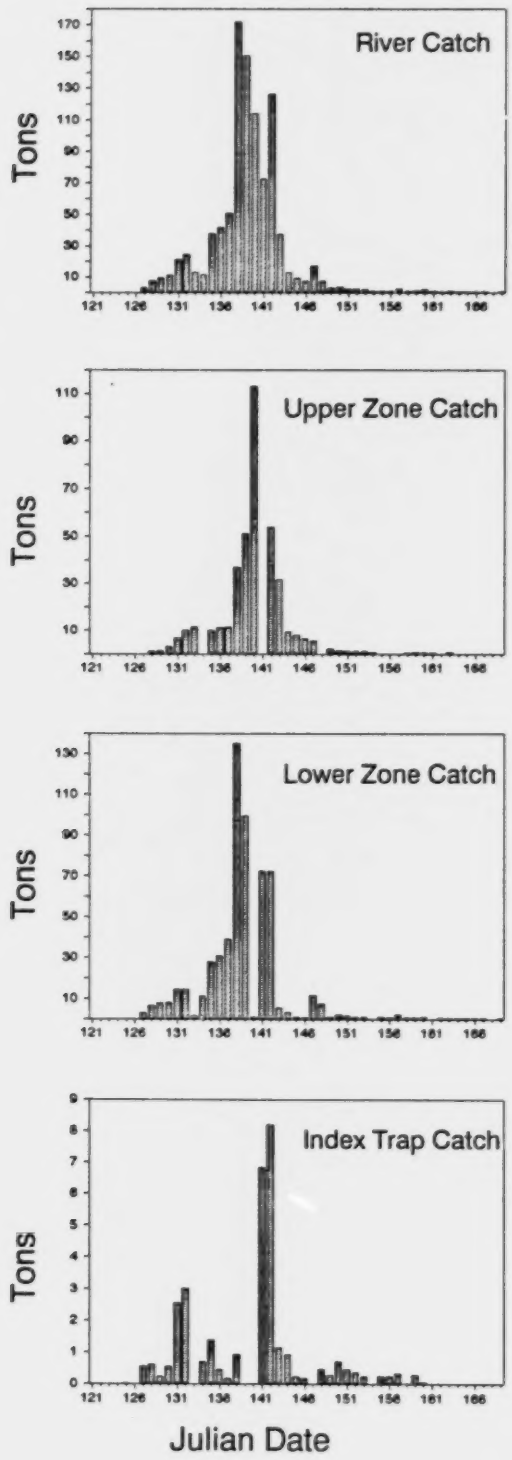

Fig. 2 Timing of gaspereau fishery of the Southwest Margaree River, 1989.

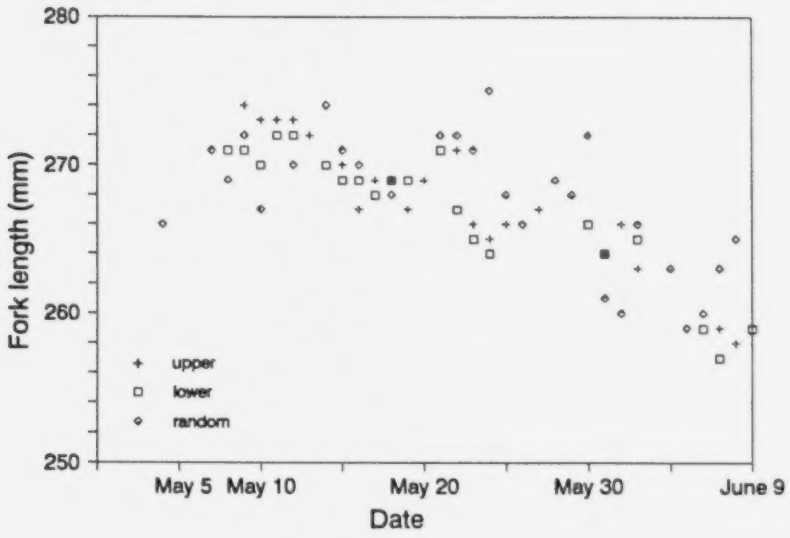

Fig. 3 Mean length (mm) of gaspereau by date from upper and lower zone stratified samples and random samples from historical index trap.

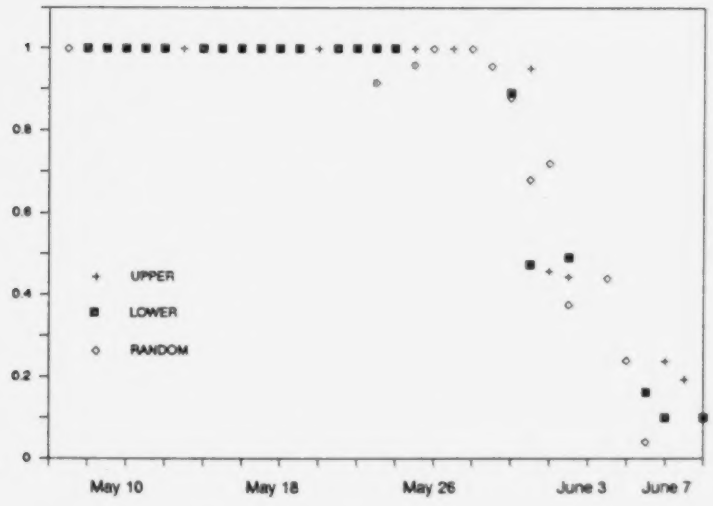

Fig 4. Proportion alewife (by number) by date in upper and lower zone stratified samples and random samples from historical index trap.

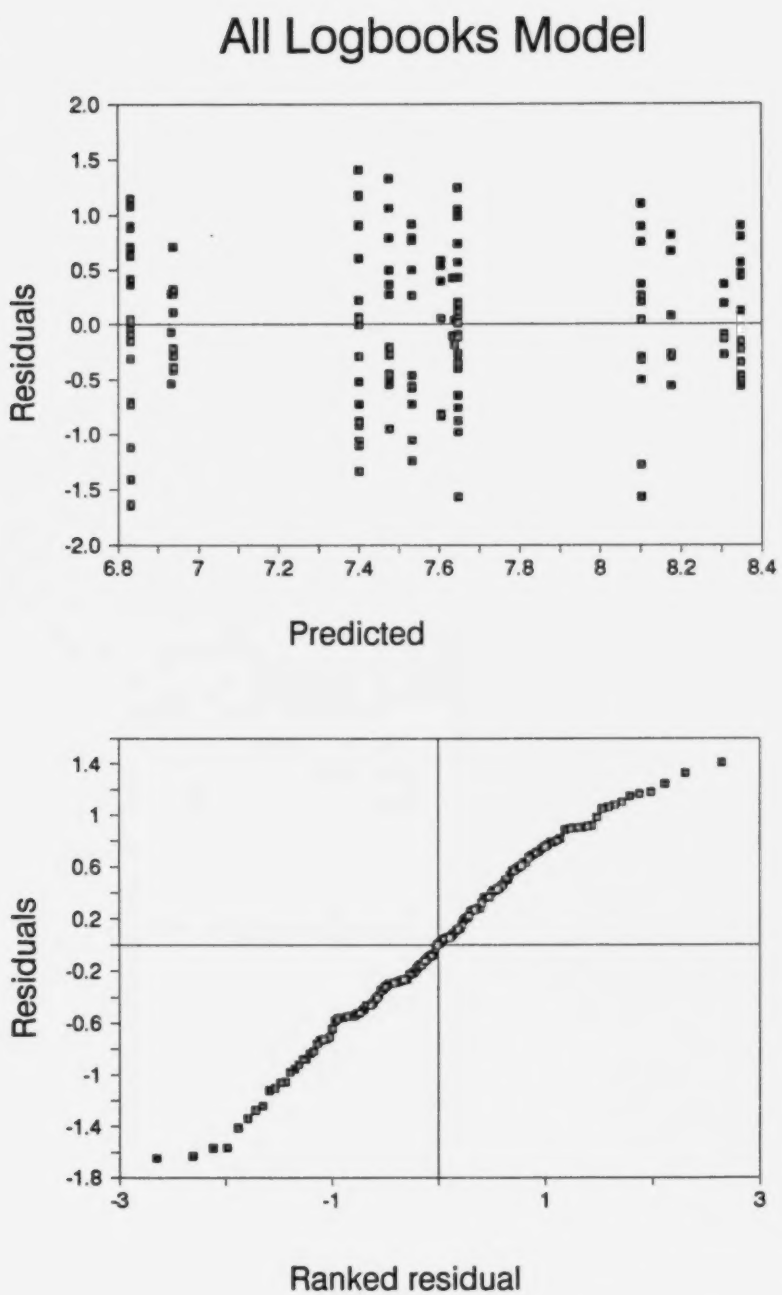

Fig. 5. Residual plots of the fall logbook catch rate multiplicative model.

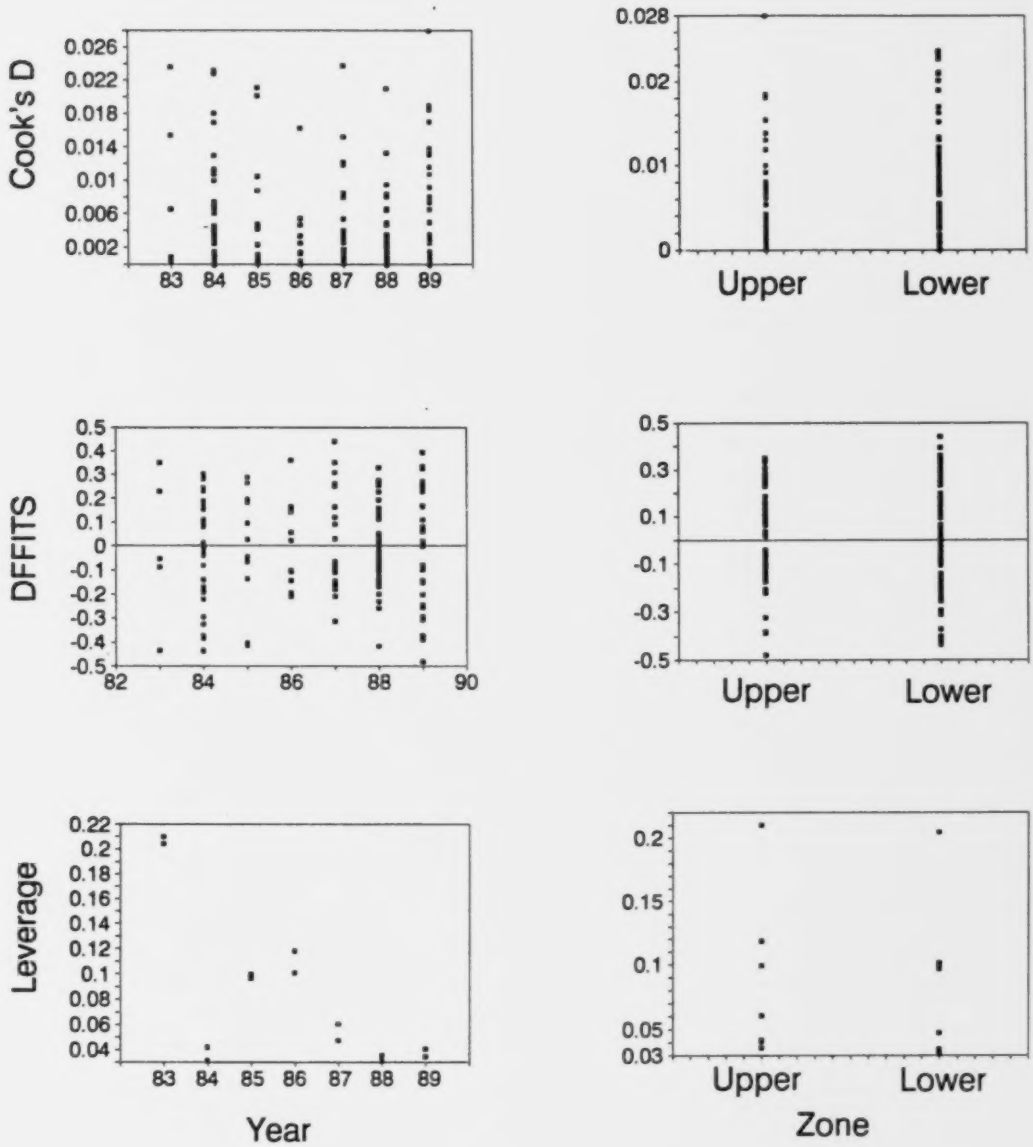

Fig. 6. Influence diagnostics of the fall logbook catch rate multiplicative model.

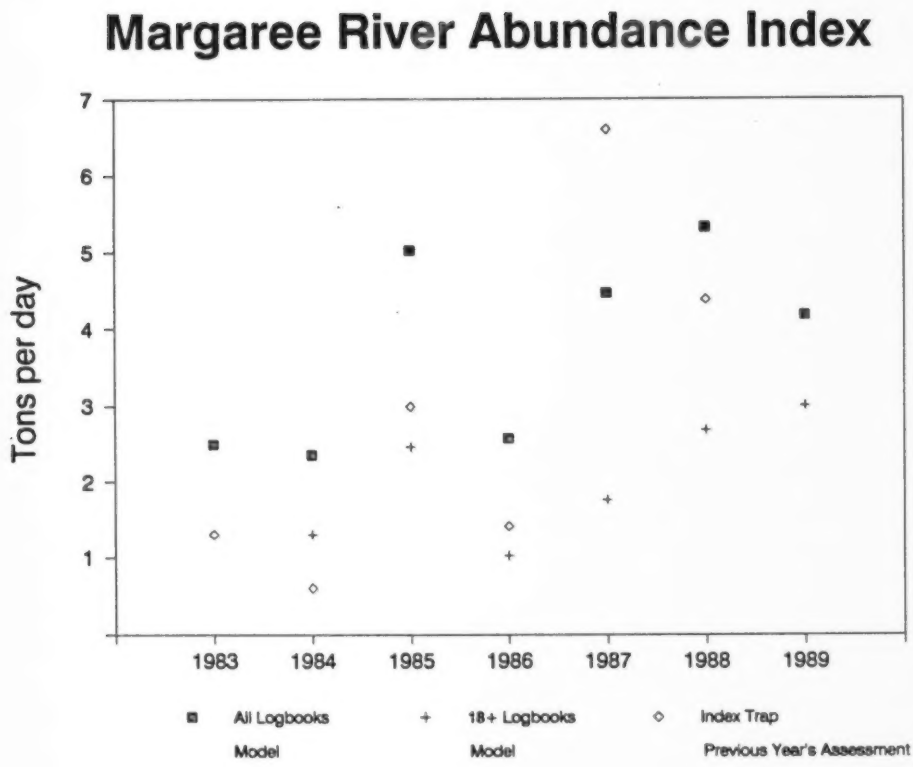

Fig. 7. Abundance indices of alewife in the Southwest Margaree River, 1983 to 1989.

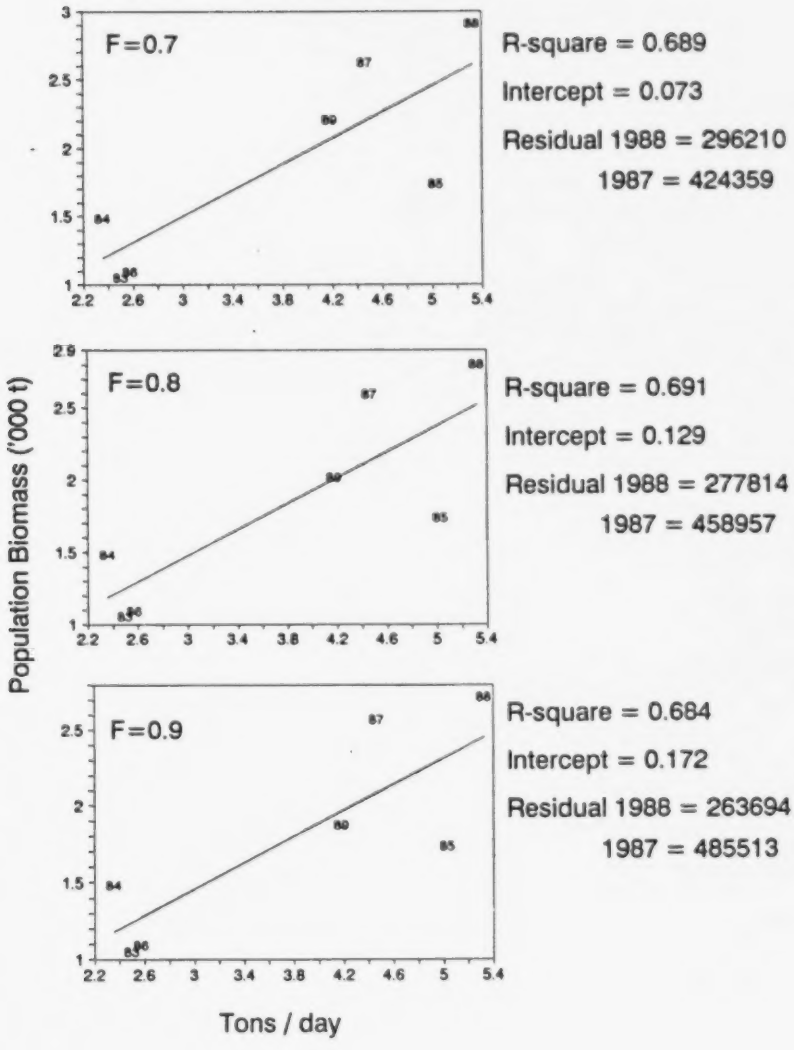

Fig. 8. Tuning plots of 1989 fishing mortality on alewife, Southwest Margaree River.

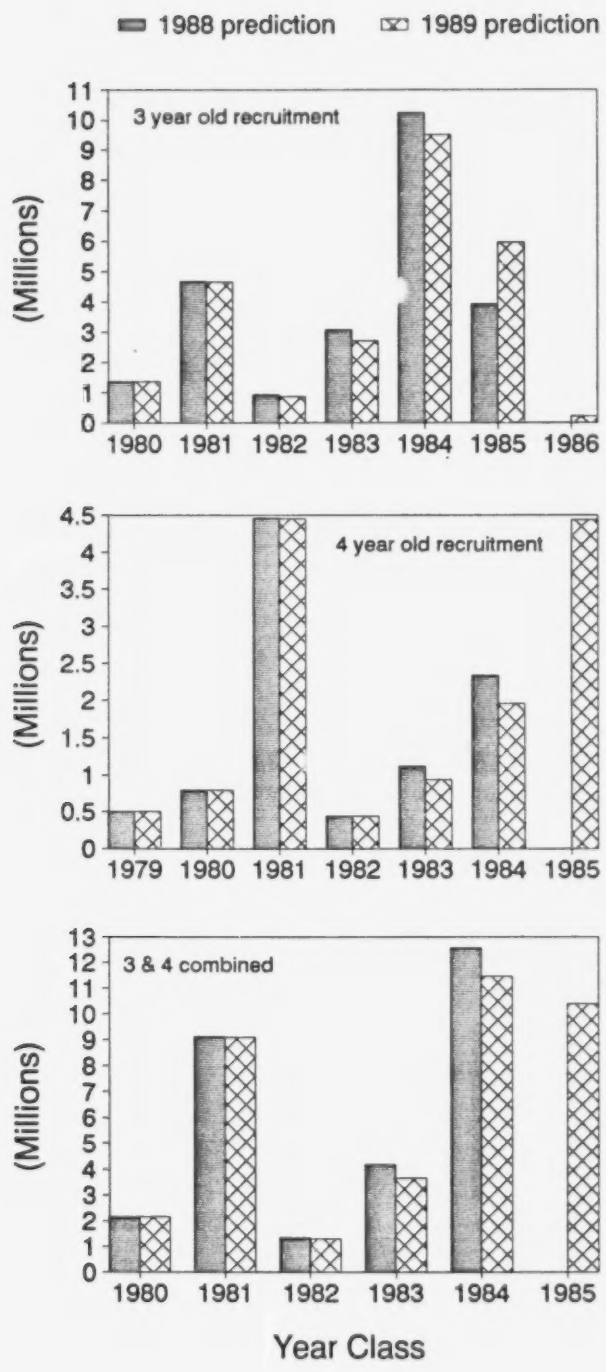

Fig. 9. Retrospective analysis of predicted year class size (number) from the 1988 and 1989 assessments.